Claims

1. A method for the production of a serial connection of solar cells having integrated semiconductor elements, characterized by the following features:

- incorporation of one or more conductive elements (20) into an insulating support layer (10) according to a pattern, whereby the conductive elements (20) protrude from the surface of the support layer on at least one side of the support layer, and the pattern calls for at least one separation line (21) having a width B and consisting of one or more conductive elements (20);
- incorporation of several spherical or grain-shaped semiconductor elements (30) into the insulating support layer (10) according to a pattern, whereby the semiconductor elements (30) protrude from the surface of the support layer on at least one side of the support layer, and the pattern provides that the areas next to a separation line (21) or between several separation lines (21) consisting of conductive elements (20) are fitted with semiconductor elements (30);
- removal of parts of the semiconductor elements (30) on one side of the support layer (10);
- application of a conductive back contact layer (50) onto the side of the support layer (10) on which parts of the semiconductor elements (30) have been removed;
- application of a conductive front contact layer (40) onto the side of the support layer (10) on which no semiconductor elements have been removed;
- making of two separation cuts (60; 61) along a separation line (21) consisting of conductive elements (20), whereby a first separation cut (60) is made in the front contact layer (40) and a second separation cut (61) is made in the back

contact layer, the separation cuts are on different sides of the appertaining separation line (21), and the separation cuts (60; 61) penetrate the back contact layer (50) all the way to the support layer (10).

2. The method according to claim 1, characterized in that the pattern provides that a distance exists between a separation line (21) consisting of conductive elements (20) and an area that is next to the separation line (21) and that is fitted with semiconductor elements (30).

3. The method according to one or both of claims 1 and 2, characterized in that the spherical or grain-shaped semiconductor elements (30) consist of substrate cores that are coated at least with one back contact layer and with one semiconductor layer arranged above it.

4. The method according to claim 3, characterized in that the spherical or grain-shaped semiconductor elements (30) have other function layers.

5. The method according to claim 4, characterized in that the spherical or grain-shaped semiconductor elements (30) have a buffer layer made of CdS.

6. The method according to one or both of claims 4 and 5, characterized in that the spherical or grain-shaped semiconductor elements (30) have a layer made of intrinsic zinc oxide.

7. The method according to one or more of claims 4 to 6, characterized in that the spherical or grain-shaped semiconductor elements (30) have a layer made of transparent conductive oxide (TCO).

8. The method according to one or more of claims 3 to 7, characterized in that parts of the semiconductor elements (30) are removed to such an extent that a back contact layer of the semiconductor elements (30) is exposed.

9. The method according to one or more of the preceding claims, characterized in that, in addition to removing parts of the semiconductor elements (30), parts of the conductive elements (20) are also removed.

10. The method according to one or more of the preceding claims, characterized in that, in addition to the removal of parts of the semiconductor elements (30), part of the support layer (10) is removed.

11. The method according to one or more of the preceding claims, characterized in that, in addition to the front contact layer (40) and the back contact layer (50), other function layers are also deposited.

12. The method according to one or more of the preceding claims, characterized in that the conductive elements (20) and/or the semiconductor elements (30) are applied onto the support layer (10) by means of scattering, dusting and/or printing, after which they are incorporated into the support layer.

13. The method according to one or more of the preceding claims, characterized in that several conductive elements (20) in the form of spherical or grain-shaped particles are incorporated into the support layer (10).

14. The method according to one or more of the preceding claims, characterized in that one or more conductive elements (20) in the form of strips are incorporated into the support layer (10).

15. The method according to one or more of the preceding claims, characterized in that one or more conductive elements (20) are incorporated in the form of a paste into the support layer (10).

16. The method according to one or more of the preceding claims, characterized in that the conductive elements (20) and/or the semiconductor elements (30) are arranged into a pattern using an auxiliary means and the elements (20; 30) are placed onto and/or into the support layer using the auxiliary means.

17. The method according to one or more of the preceding claims, characterized in that the support layer (10) is a matrix with recesses into which the elements (20; 30) are incorporated.

18. The method according to one or more of the preceding claims, characterized in that elements (20; 30) are incorporated into the support layer (10) by means of a heating and/or pressing procedure.

19. The method according to one or more of the preceding claims, characterized in that the separation line (21) consisting of conductive elements (20) is essentially straight.

20. The method according to one or more of the preceding claims, characterized in that a separation line (21) consisting of conductive elements (20) extends between two edges of the support layer (10) that are opposite from each other.

21. The method according to one or more of the preceding claims, characterized in that the removal of the elements (20; 30) and/or of the support layer (10) is done by means of grinding, polishing, etching, thermal energy input and/or by photolithographic processes.

22. The method according to one or more of the preceding claims, characterized in that the back contact layer (50) and the front contact layer (40) are deposited by PVD methods, CVD methods or other methods that have been adapted to the type of the layer in question.

23. The method according to one or more of the preceding claims, characterized in that the separation cuts (60; 61) are made using methods such as cutting, scoring, etching, thermal energy input or by photolithographic processes.

24. The method according to one or more of the preceding claims, characterized in that the width of a separation line (21) is in the order of magnitude of B = 10 μm to 3 mm, especially between 10 μm and 500 μm.

25. The method according to one or more of the preceding claims, characterized in that the distance between two separation lines (21) is in the order of magnitude of 1 mm to 3 cm, especially between 3 mm and 5 mm.

26. A serial connection of solar cells having integrated semiconductor elements, characterized in that the serial connection has at least the following features:

- an insulating support layer (10) into which one or more conductive elements (20) are incorporated according to a pattern, whereby the conductive elements (20) protrude from the surface of the support layer on at least one side of the support layer, and the pattern calls for at least one separation line (21) having a width B and consisting of one or more conductive elements (20);
- several spherical or grain-shaped semiconductor elements (30) in the insulating support layer (10), whereby the semiconductor elements (30) protrude from the surface of the support layer on at least one side of the support layer and form a pattern in which the areas next to a separation line (21) or between several separation lines (21) are fitted with semiconductor elements (30);
- a conductive front contact layer (40) on one side of the support layer (10) on which the elements (20; 30) protrude from the layer;
- a conductive back contact layer (50) on the side of the support layer that is opposite from the front contact layer (40);
- in each case, two separation cuts (60; 61) along a row of conductor elements (20), whereby a first separation cut (60) is made in the front contact layer (40) and a second separation cut (61) is made in the back contact layer, the separation cuts are on different sides of the appertaining row of conductive elements (20), and the

separation cuts (60; 61) penetrate the back contact layer (50) all the way to the support layer (10).

27. The serial connection according to claim 26, characterized in that it is produced by means of a method according to one or more of claims 1 to 25.

28. The serial connection according to one or both of claims 26 and 27, characterized in that the pattern provides that a distance exists between a separation line (21) consisting of conductive elements (20) and an area that is next to the separation line (21) and that is fitted with semiconductor elements (30).

29. A serial connection according to one or more of the preceding claims 26 to 28, characterized in that the support layer (10) consists of a thermoplastic material.

30. The serial connection according to one or more of claims 26 to 29, characterized in that the support layer (10) consists of a polymer from the group comprising epoxides, polyurethanes, polyacrylics, polycarbonates, polyesters and/or polyimides.

31. The serial connection according to one or more of claims 26 to 30, characterized in that a conductive element (20) is formed by a paste.

32. The serial connection according to one or more of claims 26 to 31, characterized in that a conductive element (20) is formed by a strip.

33. The serial connection according to one or more of claims 26 to 32, characterized in that a conductive element (20) is formed by a spherical or grain-shaped particle.

34. The serial connection according to claim 33, characterized in that a conductive element (20) is made of a conductive material in the form of a solid material, or a conductive element (20) consists of a substrate core that is coated with a conductive material.

35. The serial connection according to claim 34, characterized in that a conductive element (20) is made of copper in the form of a solid material.

36. The serial connection according to claim 34, characterized in that a conductive element (20) consists of a substrate core that is coated with copper.

37. The serial connection according to one or more of the preceding claims 26 to 36, characterized in that the semiconductor elements (30) are consist of a semiconductor material in the form of a solid material, or the semiconductor elements (30) consist of a substrate core that is coated with a semiconductor material.

38. The serial connection according to claim 37, characterized in that the semiconductor elements (30) consist of a I-III-VI compound semiconductor in the form of a solid material.

39. The serial connection according to claim 37, characterized in that the semiconductor elements (30) consist of a spherical or grain-shaped substrate core that is coated at least with one I-III-VI compound semiconductor.

40. The serial connection according to one or both of claims 38 and 39, characterized in that the I-III-VI compound semiconductor is from the group comprising copper indium diselenides, copper indium disulfides, copper indium gallium diselenides or copper indium gallium diselenide disulfides.

41. The serial connection according to one or more of the preceding claims 26 to 40, characterized in that the semiconductor elements (30) consist of a substrate core that is coated at least with one conductive back contact layer and with one semiconductor layer.

42. The serial connection according to claim 41, characterized in that the semiconductor elements (30) consist of a substrate core that is coated at least with one conductive back contact layer made of molybdenum and a I-III-VI compound semiconductor.

43. The serial connection according to one or both of claims 41 and 42, characterized in that the semiconductor elements (30) have other function layers.

44. The serial connection according to claim 43, characterized in that the semiconductor elements (30) have a buffer layer made of CdS.

45. The serial connection according to one or both of claims 43 and 44, characterized in that semiconductor elements (30) have a layer made of intrinsic zinc oxide.

46. The method according to one or more of claims 43 to 45, characterized in that the semiconductor elements (30) have a layer made of transparent conductive oxide (TCO).

47. The serial connection according to one or more of claims 41 to 46, characterized in that, on the side of the support layer (10) on which the back contact layer (50) of the solar cell is arranged, at least one of the semiconductor elements (30) has a surface via which a direct contact is established between the back contact layer (50) of the solar cell and the back contact layer of the semiconductor element (30).

48. The serial connection according to one or more of claims 26 to 47, characterized in that the separation line (21) consisting of conductive elements (20) is essentially straight.

49. The serial connection according to one or more of claims 26 to 48, characterized in that the separation line (21) consisting of conductive elements (20) extends between two edges of the support layer (10) that are opposite from each other.

50. The serial connection according to one or more of claims 26 to 49, characterized in that the width of a separation line (21) is in the order of magnitude of B = 10 μm to 3 mm, especially between 10 μm and 500 μm.

51. The serial connection according to one or more of claims 26 to 50, characterized in that the distance between two separation lines (21) is in the order of magnitude of 1 mm to 3 cm, especially between 3 mm and 5 mm.

52. The serial connection according to one or more of claims 26 to 51, characterized in that the front contact layer (40) is made of a conductive material.

53. The serial connection according to claim 52, characterized in that the front contact layer (40) is made of a transparent conductive oxide (TCO).

54. The serial connection according to one or more of claims 26 to 53, characterized in that the back contact layer (50) is made of a conductive material.

55. The serial connection according to claim 54, characterized in that the back contact layer (50) is made of a metal, of a transparent conductive oxide (TCO) or of a conductive polymer.

56. The serial connection according to claim 55, characterized in that the back contact layer (50) consists of a polymer from the group comprising the epoxy resins, polyurethanes and/or polyimides having conductive particles of a group comprising carbon, indium, nickel, silver, molybdenum, iron, nickel chromium, aluminum and/or the corresponding alloys or oxides.

57. The serial connection according to claim 54, characterized in that the back contact layer (50) consists of an intrinsic conductive polymer.

58. The serial connection according to claim 57, characterized in that the back contact layer (50) consists of a polymer from the group of the PANis.

59. The serial connection according to one or more of claims 26 to 58, characterized in that, in addition to the front contact layer (40) and the back contact layer (50), the serial connection has other function layers.

60. The serial connection according to one or more of claims 26 to 59, characterized in that the separation cuts (60; 61) are filled up with an insulating material.

61. The serial connection according to one or more of claims 26 to 60, characterized in that the serial connection is strip-like.

62. The serial connection according to one or more of claims 26 to 61, characterized in that the width of the serial connection is in the order of magnitude of 5 cm to 30 cm, especially approximately 10 cm.

63. The serial connection according to one or more of claims 26 to 62, characterized in that serial connection is joined to another serial connection in such a way that the back contact layer (50) is in contact with a front contact layer of the other serial connection.

64. The serial connection according to claim 63, characterized in that the serial connection is joined to at least another serial connection in a shingle-like configuration, whereby the back contact layer (50) lies on a front contact layer or else the front contact layer (40) lies on a back contact layer of the other serial connection.

65. The serial connection according to one or both of claims 63 and 64, characterized in that the back contact layer (50) is joined by means of a conductive adhesive to a front contact layer of the other serial connection.

66. A photovoltaic module, characterized in that it comprises a serial connection according to one or more of claims 26 to 65.